Introduction of the KALTEK cold ladle lining system into a French SG iron foundry

Performance improvements remain the major aim of foundries in an increasingly competitive international business. Today all foundry operations are affected by technology improvements, from the initial casting design, right through to the final finishing processes. New technologies are welcomed by foundries to help increase their profitability through cost reductions.

Performance enhancement not only means improvements in casting quality and productivity, but also includes better working conditions and the preservation of the environment.

This paper describes the introduction of KALTEK cold, disposable pre-formed insulating linings for pouring ladles into a French SG iron foundry. The KALTEK cold ladle lining system has enabled the foundry to reduce significantly the cost of lining pouring ladles and, in addition, improve working conditions.

General description of the foundry

The foundry described is a repetition SG iron foundry, making light mechanical components from 1 kg to 40 kg with an average casting weight of 5 kg, for the automotive industry, the truck industry, etcetera.

The advantages gained over several years have enhanced the foundry's reputation, not only in France but also in Germany and the United Kingdom, to where 40% of the production is dispatched. This foundry is shipping about 1,000 tonnes of castings each month.

Figure 1: Pouring ladle

Various quality accreditations (ISO 9002, TUV, FORD Q1 ...) show that quality is one of the prime aims of the foundry.

The foundry melts using induction furnaces. The spheriodisation is carried out using a tundish cover ladle with FerroSilicoMagnesium. There is only one automated green sand moulding line where all the pattern changes are done in 'hidden' time.

The core shop makes 400 to 500 tons of cores per month, using the amine-urethane and alkaline phenolics ester cold process. In addition, they make a very small quantity of shell cores. Most of the cores are not coated.

Liquid SG iron is poured into the mould cavity via a 1,100 kg teapot ladle, see figure 1.

Conventional lining practice

This foundry always pays particular attention to the lining practice maintaining that it is impossible to make clean castings with a ladle which is not clean. For this reason a high quality refractory concrete was used to line the pouring ladles. The lining procedure involved pouring the concrete around an internal former, drying and firing with gas burners. Ladles were carefully pre-heated before tapping. Ladles were cleaned and repaired daily. Each of the ladles lined with concrete had a lifetime of about 500 tons of liquid SG iron.

Ladle practice was as described in table 1. This cycle remained the same as the foundry changed from using concrete liners to using the KALTEK cold disposable liner system.

Introduction of the KALTEK cold insulating lining system

Several years ago, KALTEK ladle liners were introduced: KALTEK linings require no pre-heat, are highly insulating, and are easily installed and removed from the ladle. This new technique for lining demonstrated advantages in terms of higher insulating value and lining cleanliness, which reduced energy and operating costs and improved casting quality.

Table 1

Time t =0	Tap 1,100 kg of liquid iron from the furnace to the treatment ladle
Time t = 2 minutes	Transfer into the pouring ladle with inoculation into the metal stream. Remove slag.
Time t = 5 minutes	Begin pouring
Time t = 16 minutes	End pouring and coat the ladle lip with graphite wash.
Back to Time t = 0	Repeat cycle. 2 ladles are in use simultaneously

In order to verify these claims, a feasibility trial on 50 ladles was arranged. The KALTEK system consisted of a bottom board, six lateral panels, and a pre-set of five panels to make the lip area. A concrete dam constituted the teapot itself, see figure 2.

Installation of these ladles into the shell was divided in several stages:

- ☐ Preparation of a base coarse sand layer 65 mm thick.
- ☐ External pre-assembly of the boards. The integrity of the KALTEK lining pre-assembly was maintained with straps.
- ☐ Lift and insertion of the pre-assembly into the shell and onwards on to the coarse sand bed.
- ☐ Insert the concrete dam into the grooves of the KALTEK lining.
- ☐ Fill the gap between the KALTEK lining and the shell with coarse sand (15 AFS is recommended). This sand has several important functions by physically supporting the KALTEK lining during use, enhancing the insulation properties of the KALTEK lining system, and providing a permeable medium to let the spent binder gases escape. These gases are produced by the breakdown of the low temperature binders in the lining during the first taps.
- ☐ Compact the sand to make it 'homogeneous'.
- ☐ Use a rammable material on top to seal the sand preventing any sand leakage when tilting the ladle during pouring.
- ☐ Vent this rammable material by 1 mm diameter holes spaced 50 mm apart.
- ☐ Install the concrete lip as before. Prior to the first tap, the lip and damplate were gently pre-heated with a small gas burner. No pre-heat of the KALTEK ladle lining boards was required.

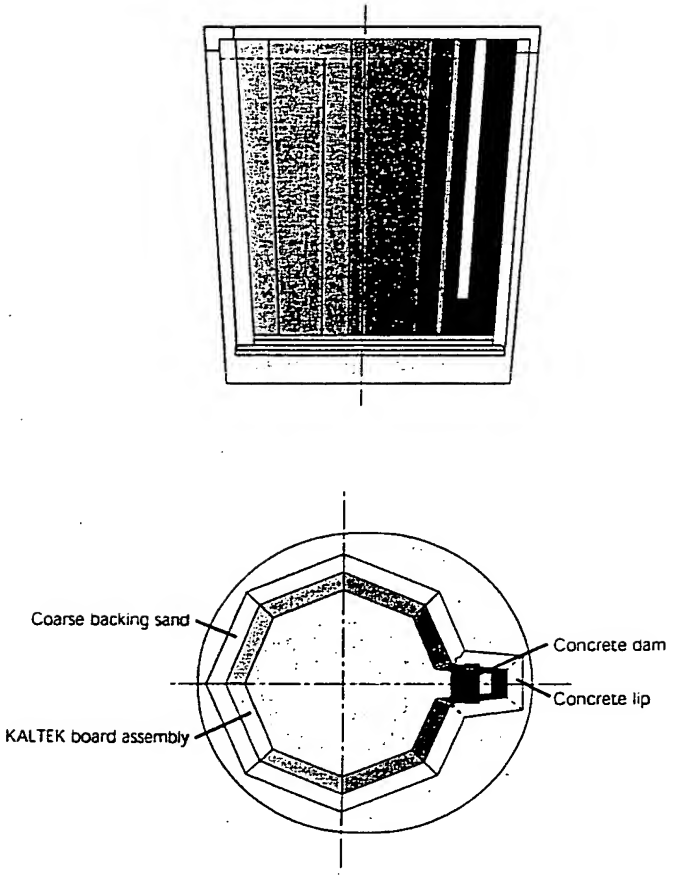

Figure 2: Panel ladle for trials

The following benefits were identified during this 50 ladle trial:

- Elimination of costly and noisy ladle preheating operations.
- Better insulation – furnace temperature was reduced by more than 10°C.
- Improved working conditions.

The lining had reduced the capacity of the ladle from 1100 kg to 800 kg. However, the foundry decided that the benefits demonstrated by this long term test of the KALTEK ladle lining system, justified development of a new ladle design. In partnership with Foseco, a programme was undertaken to design a ladle shell and KALTEK lining system which would meet the production requirements and optimize the direct and indirect benefits obtainable from using the KALTEK lining system.

The 1,100 kg ladle for regular production

Foseco designed a specially shaped lining for this new ladle with two objectives:

- 1,100 kg working capacity.
- Lower thermal capacity damplate.

This new ladle lining, see figure 3, consisted of three elements:

- A bottom bowl
- A top ring
- A concrete damplate

Installation of the lining into the shell was much simpler compared to the original trials but it was installed in much the same way:

- The bottom bowl was laid onto the coarse sand bed.
- A refractory glue joint was deposited on the horizontal flat joint of the bottom bowl.
- The top ring was installed on this glue joint.

All the other stages of the installation were identical to those described previously.

Benefits from the KALTEK cold ladle lining system

After several years of experience, having used several hundred KALTEK ladles, the foundry compared the two lining processes.

The advantages that KALTEK cold ladle lining system identified by the foundry were linked with costs and quality, as well as improvements to the working environment.

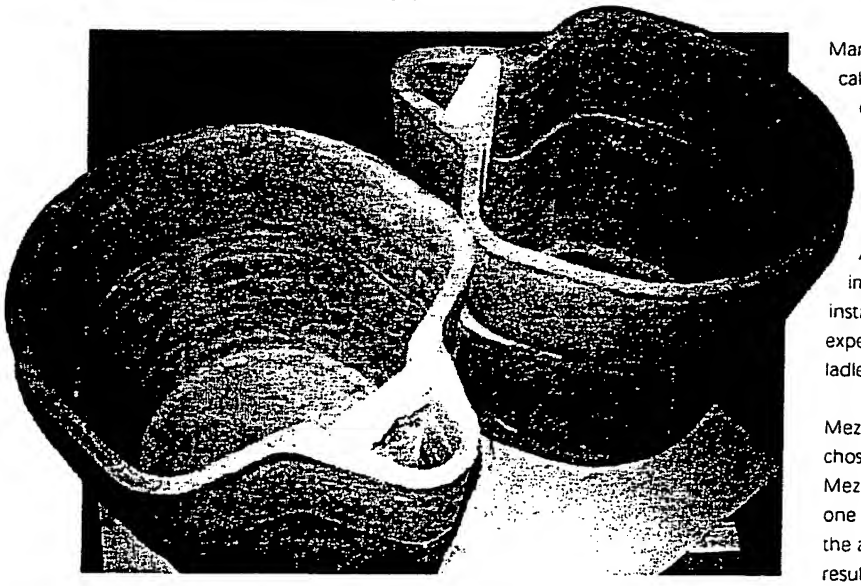

Figure 3: 1.100 kg capacity teapot KALTEK ladle

Summarising:

- Better insulation provided.
- Furnace temperature reduced by 20°C (this was obtained after some months of experience).
- Same average pouring temperature and lower variance.
- Less wear of the furnace refractory lining.
- Rate of temperature losses reduced considerably.
- Lower shell external temperature, better working environment.
- Lower direct labour costs on lining operations.
- Less gas consumption for pre-heat.
- Significant savings in FeSiMg alloy additions because of the lower tap temperature.
- Significant reduction in non-metallic inclusions.
- Better process control.
- Improved safety and working conditions.

Installation, repair, cleaning and knock-out of pouring ladles was calculated to be three minutes per ton of liquid metal with conventional concrete linings, compared to under two minutes per liquid ton when using KALTEK linings. It is simple to cycle a KALTEK lined ladle whereas many hours may be spent knocking out and relining a conventional system.

Since KALTEK linings are replaced more frequently, than conventional concrete lining systems, there is a lower build up of slag and dross on the ladle surface and hence less risk of contamination.

Economics

Some benefits of using the KALTEK cold ladle system process could be given a value. However many benefits are not easily measured directly, but are still of great value. Table 2 highlights the major savings measured by the foundry.

Many other benefits could have been added to the calculations if they could have been quantified. For example the increased life of the furnace refractories and the improvement in working conditions.

Automatic pouring station

As a result of the foundry's continuing aim to improve general performance, it was decided to install an automatic pouring station. Following the experience gained, as reported, the KALTEK cold ladle lining system was specified.

Mezger AG, a well known Swiss company, was chosen for this project. The internal profile of a Mezger pouring basket is shown in figure 4 and is one of the key factors to a successful operation of the automatic pouring system. This profile is the result of many years of experience. In order to

comply with this shape requirement, Foseco designed a special KALTEK cold ladle liner, see figure 5.

The ladle lining is in two halves but the split joint is vertical instead of horizontal, and is, in addition, exposed to the impact of liquid iron on tapping. Some specific features in both the design and manufacturing, enabled identical performances to previous practice.

Installation practice differs slightly since the two halves are externally pre-assembled before introduction into the metallic shell, as shown in figure 6. All the other operations remain the same.

The foundry has been using these new ladles for several months without any particular problems.

Comparison of yearly costs in French francs

	KALTEK ladle lining system	Conventional concrete ladle lining
Refractory material for pouring ladles	462,700	116,200
Labour costs	51,100	107,400
Energy (additional cost)		
Melting and preheating		+ 416,000
Various consumables (alloy ...)		+ 129,300
(additional costs)		
Disposal	13,000	2,500
Casting quality (additional cost)		+ 100,200
Total yearly costs	526,800	871,600

Annual savings	Absolute value	**344,800 French francs (£44,200)**
Per shipped ton		**31.30 French francs (£4.02)**
Tool investment		**60,000 French francs (£7,700)**

Table 2: Economical balance

Conclusions

Introduction of the KALTEK system of insulating and disposable preformed cold liners for pouring ladles, has enabled the foundry to enhance their global performance and competitive advantage.

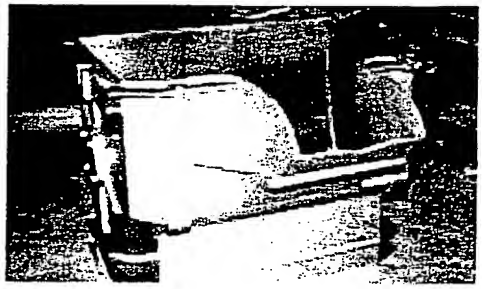

Figure 4: Mezger shell

Figure 6: The pre-assembled KALTEK ladle lining system

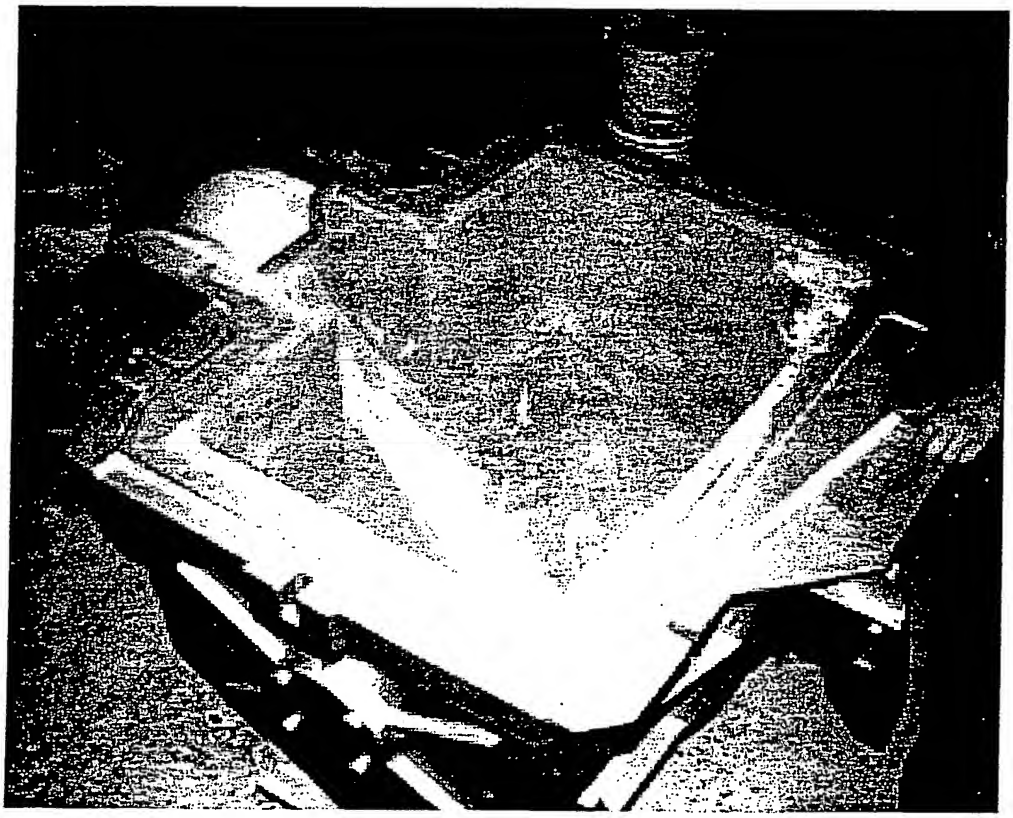

Figure 5: KALTEK lining installed

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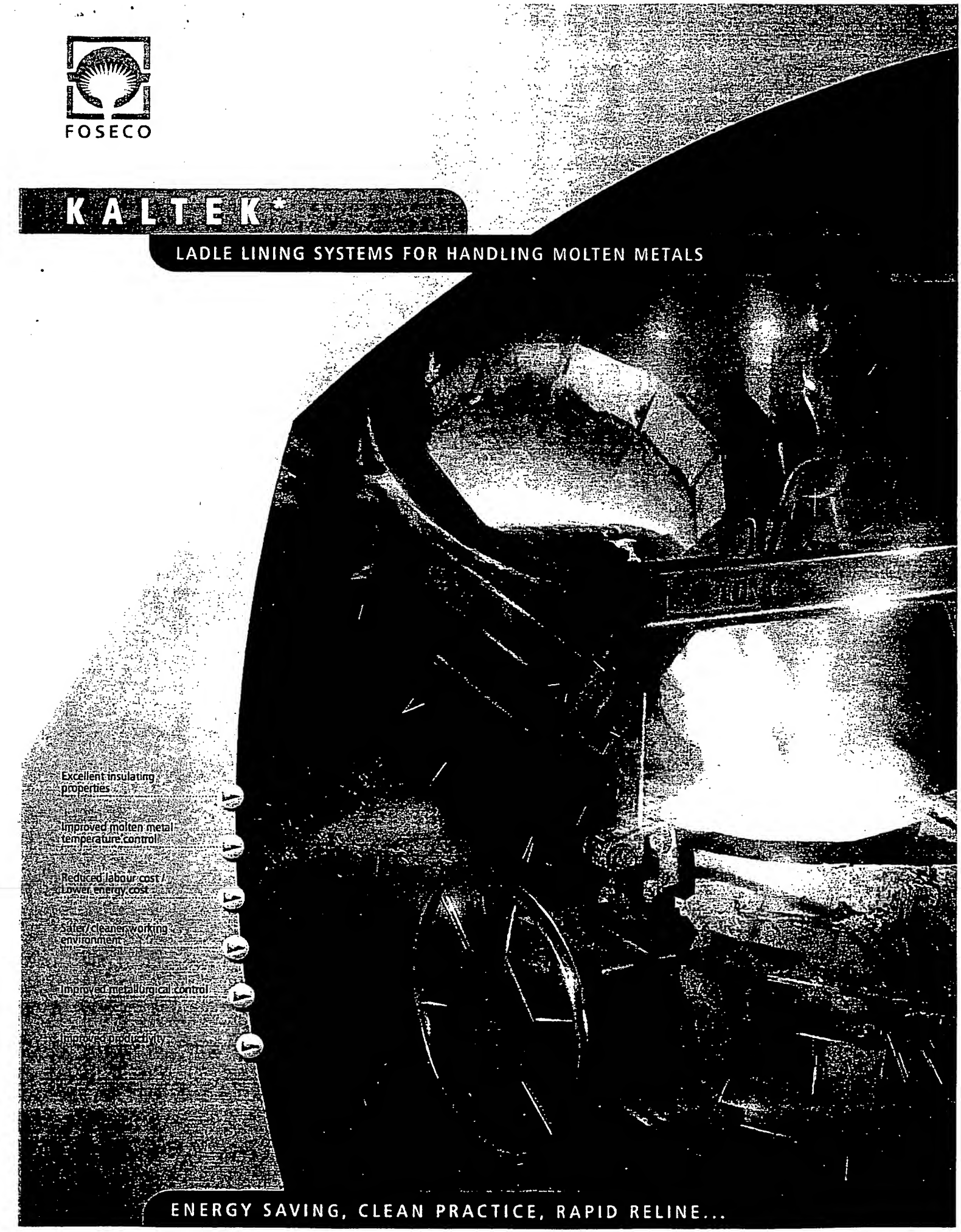
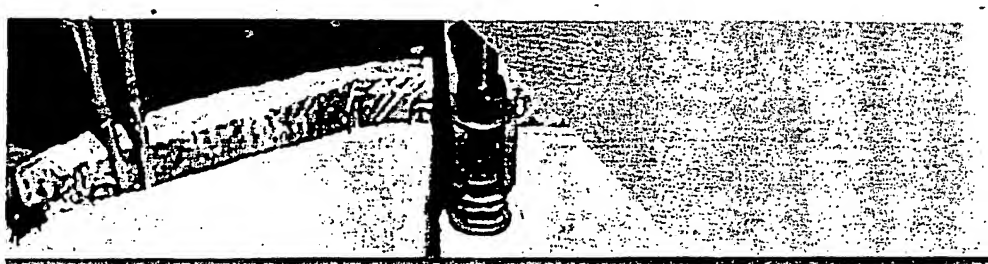
LADLE LINING SYSTEMS FOR HANDLING MOLTEN METALS



- Excellent insulating properties
- Improved molten metal temperature control
- Reduced labour cost / Lower energy cost
- Safer / cleaner working environment
- Improved metallurgical control
- Improved productivity

ENERGY SAVING, CLEAN PRACTICE, RAPID RELINE...



KALTEK LADLE LINING SYSTEMS

IMPROVED FOUNDRY PROC

An integrated approach to improve performance

KALTEK® ISO ladle lining systems are the latest addition to the KALTEK® range of ladle lining systems. The portfolio of preformed one-piece linings, board systems and castable powder means that optimal lining systems can be developed to meet your molten metal transfer needs.

KALTEK ladle systems provide benefits in improved foundry processes, increased process control and enhanced productivity. Combining efficient insulation with refractory stability, KALTEK systems assist in improving metal cleanliness whilst lowering energy, cleaning, upgrading and scrap costs. Ladle preparation times are reduced and preheating costs minimised. Metal temperature variation during pouring is reduced and casting quality increased. Finally, KALTEK ladle lining systems improve the overall work environment by reducing noise, and radiant heat in the melting area.

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SSES FOR HANDLING MOLTEN METALS

Energy savings and more

Typically 60-70% of foundry energy costs relate to the melting, holding and pouring of the metal. The insulating properties of Kaltek provide energy savings through the potential for lower tapping and holding temperatures. The KALTEK ladle lining systems generally need no preheat, so energy costs associated with gas-fired or electric preheaters are virtually eliminated. Reduced tapping and holding temperatures also allow furnace refractories and electrodes to last longer.

Improved ladle preparation and cleaning room productivity

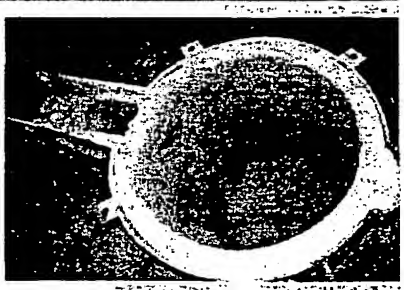
KALTEK ladle lining systems minimise ladle turnaround time. Ladles with KALTEK systems can usually be taken out of service, relined, and returned in less than one hour, without the need for labour intensive slag removal and refractory maintenance, this allows for a possible reduction the number of ladles used in the foundry. In addition, lower tap temperatures in batch pouring operations reduce tap-to-tap times.

Productivity gains in the cleaning room resulting from cleaner castings manufactured with improved temperature control significantly reduces scrap and upgrading costs.

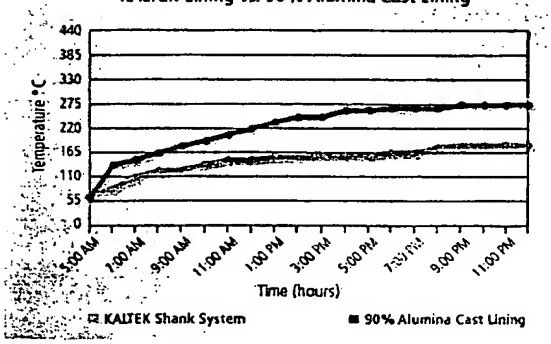
Improved work environment

The KALTEK ladle lining systems offer unique environmental and ergonomic advantages in the melting and pouring areas. Lower ladle shell temperatures allow ladle operators to reline and return ladles to the melting area more quickly, without the labour-intensive and dusty chipping and hammering operations required to maintain conventional refractories. Reducing the time for which aggressive tools such as pneumatic chisels have to be used reduces the risk of injury and conditions such as "Vibration White Finger".
Eliminating extensive ladle preheating reduces noise and provides a more comfortable working environment in and around the pouring area. Safety is also improved as gas burners and other heating devices are not left unattended for several hours.

KALTEK shank system



KALTEK ISO system



Insulating properties of KALTEK systems